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AUTHOR Cannella, Gaile S.
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ABSTRACT

All too often educators establish a "pretest, skill, posttest" type of curriculum. While this approach has an educational value, it must be used within a developmental framework based on individual thinking and learning style. Thus, a thorough knowledge of cognitive development is necessary. A review of the body of knowledge concerning individual learning style suggests some implications for practice. The aim of the following review is to provide an introduction to that body of knowledge and to suggest some implications for practice. The preoperational stage of development, as described by Jean Piaget, is especially important to early childhood and elementary educators, since a majority of children are preoperational at the time formal schooling is begun. A complete discussion of cognition requires recognition of individual differences in the learning process. Investigations of the manner in which cognitive functions are executed, or of cognitive style, attempt to identify individual differences in the way children think, perceive, remember, and gather and use information. Two dimensions of cognitive style have been studied: reflective/impulsive and field-dependent/field-independent responses. Cognitive theory in general suggests implications for establishing the classroom as a learning environment based on an activity-oriented curriculum as well as for selecting developmentally appropriate reading and arithmetic materials. (Sample lesson plan objectives and activities for children with developmental reading problems are appended.) (RH)

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Cognition:

Development and Education

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Gaile S. Cannella
University of Northern Iowa

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One of the current movements in education today can be described as the "back to basics" movement. This thrust has lead to placing a greater emphasis upon reading, writing, and arithmetic, and especially the skills involved in these areas. This movement also tends to be dominated by certain kinds of mental activities; i.e., verbal, analytic, abstract, rational, and objective.[1] However, before "jumping on the bandwagon," certain questions should be considered. First, there are basic philosophical issues. What is the ultimate goal or purpose of education for the individual and society? Is that purpose to teach reading, writing, and arithmetic which are adult necessities; or is that purpose to instill and nourish a love for learning? Do the purposes of education vary for different individuals? Secondly, theoretical questions exist. How are intrinsic and extrinsic motivation involved in learning? What are the best methods for developing abstract thinking and abstract skills? Should educators teach abstractly to develop this ability; or should teaching progress from concrete to abstract? Do the cognitive abilities of young children allow for abstract, rational, and objective learning? How can individual differences be recognized and "treated"? Two of these questions are discussed in detail: (1) development of cognitive ability, and (2) individual differences in cognitive ability. With these concerns, the question becomes, "What does cognitive theory suggest for teaching the basics?"

Cognition

In developing a plan of action for "educating," the knowledgeable teacher first determines the nature of the learner. In dealing with children, the educator asks: How do children learn? How do they think? Is there a knowledge deficit in the thinking of children; or is there a rational, perceptive difference in the way children think? All too often, we as educators establish a "pretest, skill, posttest" type of curriculum. While this approach has an educational value, it must be used within a developmental framework based upon individual thinking ability and learning style. For this reason, a thorough knowledge of cognitive development is necessary in order to establish an educational curriculum that meets the needs of children.

Cognition, or the development of intelligence, is a very broad, abstract, and puzzling concept. Theorists such as Bruner[2], Gagne[3], and Guilford[4] have each developed an approach to understanding intelligence. However, the most detailed theory of intellectual development has been postulated by Jean Piaget, a Swiss psychologist. He has been the major figure responsible for the surge of interest in cognitive development during the past ten years.

Through observations based upon individual responses, Piaget has formulated a stage theory of cognitive development.[5] Between birth and adulthood, the child progresses through four stages of development: (1) the sensori-motor period, (2) the preoperational period, (3) the concrete operational period, and (4) the formal operational period.

The average child is in the sensori-motor stage of development from birth to approximately 2 years of age. From birth he begins the never ending process of modification and adaptation based upon interactions with people and objects. Even the newborn reflexes of sucking and grasping are affected in some manner by the infant's first contact with the environment. By the end of his first year, the child achieves object permanence and begins the process of developing such concepts as time, cause-and-effect, and space-and-gravity. By the end of the sensori-motor period, the child uses telegraphic language, recognizes pictures of familiar objects and can play simple games.

At this point the child enters the preoperational stage of development. This period, from approximately 2 to 7 or 8 years of age, is dominated by inconsistancy. The child is able to manipulate a system of language and action symbols and communicate them to others. Yet, this language ability is often misleading. The child remains bound by perception, not by a logical thinking process. He is characterized by irreversibility of thought, egocentrism, inability to attend to transformations or to decenter thought processes, and transductive reasoning.

The third stage of development, from approximately 7 or 8 to 11 years, is called the concrete operational period. At this stage a child begins to use abstract thinking. Judgment becomes more stable, consistent and logical. However, in dealing with concepts, especially new concepts, the concrete operational person is still at a disadvantage

if these concepts are presented in an abstract form. As with stage one and two, it remains necessary to manipulate concrete materials, to be capable of acting upon concepts.

The final stage, that of formal operations, is analogous to logical adult thought. The formal operational person is able to consider all possibilities without dependence upon concrete reality. He can hypothesize and use scientific reasoning to analyze situations and solve problems. He is capable of abstract thinking.[6]

Since education begins during the early years, the first teachers expected to deal with the "back to basics" question are those involved in early childhood and elementary education. One stage is especially important to these educators, the preoperational stage. The majority of children are preoperational at the time formal schooling is begun. A 5 to 8 year old brings to school certain limitations in dealing with the world around him. These limitations do not represent a knowledge gap, but a qualitative difference in the way a preoperational child perceives the world. As mentioned earlier, the child's thought is bound by perception. He is not capable of consistant, logical thinking. During the later part of the preoperational stage, occurring within a 5 to 8 year old, three types of thinking are mastered.

Logical Thinking

A preoperational child forms conclusions by what seems to be, rather than what logically must be. He cannot begin an operation and logically follow it through to the end. Classification, or grouping

objects or events according to their specific properties, is an illustration of logical thinking ability. For example, when given a group of shapes and colors, the preoperational child would be asked to put objects that are alike together. Many reactions could result, usually in the following order: (1) a picture is made with the objects, (2) the objects are placed in a line using a pattern, such as "red, blue, red, blue"; or changing criteria for placement, such as "red triangle, blue triangle, blue circle, yellow circle", (3) objects are placed in groups that are alike using either color or shape; however, all objects are not used, and (4) all objects are placed into correct groupings by either color (red group, yellow group, blue group) or shape (triangle group, square group, circle group). When a child can achieve correct groupings, he is then asked to put objects that are alike together but make different groups. In other words, he is asked to use a second criterion. A preoperational child is often unable to see shape groupings if he/she has made color groupings previously, or to see color groupings if he/she has made shape groupings previously. This limitation is termed the inability to decenter. The child centers upon the characteristic that was seen first and is unable to "comprehend" independently additional characteristics.

The preoperational child cannot analyze the logic of a hierarchical relationship. When shown three triangles and two squares and asked, "Are there more shapes or more triangles?", the child who has not achieved concrete operations will invariably answer, "triangles".

This same child may have previously demonstrated recognition that triangles and squares are both shapes, but does not use this logic in a visual operation. This limitation is termed the inability to comprehend class inclusion. The child is dominated by what he sees, his visual perception, rather than logic.

Multiple classification involves two groups of objects with different characteristics. The child is asked to find an object that would intersect both groups. For example, using a group of green objects and a group of balls, the intersection would be achieved using a green ball. This is an advanced perceptual/logical ability that is not achieved by many children who enter first grade.

Relational Understanding

Relational understanding is the ability to distinguish graduated differences. These differences may occur in people or objects; size, color, weight, thickness, etc. The differences may occur in relation to the five senses; sights, sounds, textures, smells, tastes. Graduated differences occur in ordering of events; both personal events that happen to a child and more abstract events that may occur in a story. Finally, there are relational understandings that are not achieved without reaching the stage of formal operations. An example of formal abstract relational understanding are the graduated differences between an extreme conservative and a staunch liberal.

Piaget has called relational understanding seriation. The most often used seriation task is the arrangement of elements according to

increasing or decreasing order, from smallest to largest, or largest to smallest. Objects are usually placed into unrelated groups by a very young preoperational child. A child who is slightly more advanced attempts through trial and error to order the elements. Finally, ordering comes very easily, using a preformed measurement plan, for a child who has achieved understanding of size relationships.

Multiple seriation consists of constructing two relationships found within one group of objects or one situation. For example, one might arrange a group of balls according to size (small to large) and color intensity (light to dark). The majority of children do not achieve this combination of perception and logical understanding until 7 or 8 years of age or older.[7]

Conservation

Conservation is the ability to understand that certain properties such as number, length, quantity, mass, or weight within a system remain the same regardless of transformations that may be performed within the system. Conservation is a vertical process which begins in the transitional preoperational child and culminates with the attainment of formal operations. Abilities most often associated with preoperational children are conservation of number and substance.

Conservation of number deals with the realization that numbers are constant. Two always equals two; or seventeen always equals seventeen. The preoperational child is given two equal groups of objects, in this instance cups and saucers. First he is asked to

complete one-to-one correspondence by matching the two groups, one cup to one saucer. Then he is asked to count the members of each group and tell if the groups are the "same". In most instances, a five or six year old achieves one-to-one correspondence, counts, and recognizes that the groups are equal. However, the next step is to move the objects in one group away from each other to form a group that appears to be larger than the second group. When asked if the groups are the same or different, a preoperational child uses perception rather than logic. The group that is spread apart appears to have more objects. If the child has reached concrete operations, he/she states that "of course the groups are the same" and proceeds to count them.

Conservation of substance deals with the invariance of material, such as clay dough, or various foods. The preoperational child is shown two equal size balls of clay. One ball is then rolled into a long, thin shape or broken into many pieces. The child is asked, "Does one have more or less than the other, or are they the same?" The preoperational child judges that one of the balls now has more or less. He is unable to logically comprehend that no clay was added or taken away, therefore, the portions remain equal.

Both conservation of number and substance bring into focus major limitations in preoperational thinking. First of all, the child's thinking is irreversible. The preoperational child cannot retrace an event within his/her mind to the point of origin. This is demonstrated through the inability to remember that the two groups of objects were

originally equal in number. An additional example requiring reversibility is 5 + 3 = 8, 8 - _ = 3. Secondly, states dominate a preoperational child, rather than transformations. Changing an object or substance from one visible state to another represents a transformation. A preoperational child focuses on the present state of the object rather than consider changes that have occurred. Finally, in conservation tasks, the preoperational child again demonstrates that he/she is bound by perception. He makes judgments according to what he sees, rather than using logic or reasoning.[8]

Exhibited in the thinking of preoperational children are additional characteristics that form limitations in understanding the world

- The preoperational child is unable to see the world from another person's point of view. He is egocentric.
- The preoperational child believes that inanimant objects are alive and can feel. This belief is termed animism.[9] The child may make such statements as:

  "The sun is alive because it moves and follows me."

  "The toy lamb can see me."
- The preoperational child is beginning to develop an ability to form mental pictures, within his mind, of static or motionless objects as kinetic or moving objects. This ability is termed mental imagery. The child is learning to create mental pictures of objects that are to be moved, before seeing the actual movement.[10]

- The child's thinking which expresses a causal relationship from one particular instance to another instance is called transductive reasoning. An example would be the child knowing that Daddy's shaving requires hot water, therefore, if the hot water is on, Daddy must shave. A causes B so B causes A.[11]
- As mentioned earlier, during this stage, the child is very concrete. He must have tangible objects to represent every thought. This is displayed by the kindergarten or first grade child who expresses the belief that a name is part of an object. "We cannot call a dog an elephant."

Cognitive Style

Piaget was concerned with a cognitive development theory which involved processes experienced by all children, allowing for individual differences in rates of development. A discussion of cognition would not be complete without the recognition of individual differences in the learning process. At this point one begins to consider the manner in which cognitive functions are executed, or cognitive style.[12] This area of cognition involves the individual differences in the way a particular child thinks, perceives, remembers, gathers and uses information.

Basically two dimensions of cognitive style have been studied: reflective/impulsive, and field-independent/field-dependent.

Kagan, Moss, and Sigel[13] found that when given a task or a problem to solve, children would approach the solution in two ways. Some children respond slowly and with accuracy. These are reflective children. Others respond rapidly and with many errors. These are impulsive children. A reflective child spends a great deal of time in solitary tasks and is usually emotionally controlled. Although, extreme reflectives do exist, in general these children are able to analyze a situation and make the necessary choices. An impulsive child often appears to be very curious and exploratory, but also very distractible. He/she seems to run from "toy to toy" in a play situation. He has great difficulty in making choices. He would rather risk a wrong answer than consider alternatives. In most instances, school learning requires careful, systematic concentration. It is no surprise that impulsives often have difficulty in a classroom situation. Messer[14] found that although the relationship between reflectivity-impulsivity and IQ is small, boys who were not promoted in the first grade were more often impulsive than their promoted classmates with similar IQs.

One of the most widely studied dimensions of cognitive style is field-independence/field-dependence. This dimension measures the extent to which an individual is able to overcome the distracting influences of irrelevant background material and distinguish designated parts of the whole.[15] A field-independent child can differentiate and analyze the parts of a whole. A field-dependent individual is dominated by the field and has difficulty analyzing parts.[16]

Although field dominance does not seem to influence learning ability, the two types of individuals differ in response to stimuli:

- Field-dependent persons attend particularly to the social field and will look to others for aide in determining values and beliefs. These people learn and remember better when involved with social material. Field-independent people are better at learning and remembering impersonal material.
- Field-dependent individuals are more influenced by social reinforcers than field-independent individuals.
- Field-independent individuals are better suited when dealing with unstructured situations. They can handle organization of material, which is often a problem for field-dependent individuals.[17]

Cognitive style appears to be influenced by both heredity and environment. Current research, to determine brain function, has lead investigators to believe that each hemisphere of the brain is responsible for certain kinds of mental activities. For each individual, left/right hemisphere dominance may vary. Learning style is quite possibly a partial result of this dominance. A predominantly left-hemisphere individual could adjust fairly well to the analytic, verbal expectations of a school environment. However, the right-hemisphere individual, who is pre-verbal, emotional, spatial and passive could find himself in an environment requiring that he learn using his weakest, rather than strongest abilities.[18]

Witkin[19] has also found that learning style develops through socialization practices. For example, Mexican American children were found to be more field-dependent than Anglo-American. The Mexican Americans are often raised in an environment that emphasizes respect for social convention, protectiveness, and close ties between mother and preadolescent.[20] Yet, most school environments reflect a very field-independent situation.[21]

Classroom Implications for Cognitive Theory

Although an entire elementary school philosophy and curriculum could be written based upon how children learn, two major topics are discussed within this text: (a) the classroom as a learning environment, and (b) current curriculum materials.

The Learning Environment

Cognitive theory provides certain general implications appropriate for all children within a learning environment. These implications include: (a) teacher climate, (b) learning plan, and (c) classroom structure.

First of all, the teacher becomes a facilitator of learning, rather than a director or dispensor of worksheets and skill practice. He/she is interested and knowledgeable in the area of child development, curriculum content, and teaching methods and able to capitalize on the "teachable moment" for each individual child. Both the child who needs maximum structure, with calculated step-by-step direction, and the child who needs freedom to explore, learning from his

environment without adult intervention, are provided for. Through knowledge of specific individual differences, the appropriate amount of guidance is given as needed. The facilitating teacher is free and spontaneous, with the ability to maximize productive activity and minimize chaos. Children's abilities and limitations are understood, while carefully watching and listening to ascertain real meanings for behavior.

As dictated by cognitive theory, the structure of the elementary school classroom is arranged to enhance an activity oriented curriculum. Preoperational and concrete operational children learn through manipulation of objects, providing concrete experiences for concept development. Materials are available where children can reach them. Children are allowed spontaneous talk while working in group and individual activities. A variety of materials and activities enhances the possibility that the needs of individuals with different learning styles will be met.

In a cognitively based, activity oriented curriculum, children and teacher share planning for lessons and activities.[22] Many teachers appear to be intent on teaching children how to read and how to work arithmetic problems, without the recognition that all children are "naturally" developing the ability to learn. Foremost, in the development of learning ability is the shared planning of what will be learned.

Curriculum Material

In considering curriculum for an elementary school classroom, most educators think "arithmetic" and "reading", which are legitimate concerns. For his/her entire life, an adult is exposed to situations that require these skills. Driving a car, buying groceries, buying clothes, cooking, fixing a child's new toy, all require arithmetic, reading or both. These skills are necessities. However, as educators, psychologists, and neuroscientists continuously learn about the human brain and how individuals learn, we must apply this to the educational setting. How can cognitive theory be applied to the teaching of arithmetic and reading?

As stated earlier, a concrete, activity oriented environment with a facilitating teacher, who provides options and shared planning is the beginning. This approach can be taken with both arithmetic and reading. The teacher begins by assessing the cognitive abilities of all children in the classroom, not using standardized abstract achievement tests but concrete materials. From this assessment, he/she and the students plan learning situations;

'Can the individual child classify objects, concretely, then abstractly? If not, he may have difficulty both memorizing and applying phonics rules, an activity that requires decentration.[23] He may find it impossible to comprehend and apply all properties that letters and words have; configurations, sounds, phonics properties, or position in the alphabet or in a sentence.[24] The facilitating teacher provides both structured and spontaneous

activities that give the child opportunities to explore characteristics and properties first concretely (objects), then semi-concretely (pictures), and finally abstractly (words and thoughts).

·Can the individual child conserve and form serial relationships? Without conservation, the child cannot understand that 3 objects always equal 3, 8 objects always equal 8, 17 objects always equal 17. He cannot recognize equal quantities such as: 5 + 3 = 8, 4 + 4 = 8, 6 + 2 = 8. Reversing operations in arithmetic (3 + 5 = 8, 8 - _ = 5) is impossible, yet it can usually be found in the child's grade level arithmetic workbook.[25] It may be difficult for him/her to transfer letters to correspond to appropriate sounds, such as: great, grate, eight.[26] Without seriation, the child may have difficulty ordering letters in the alphabet, separating spoken words into their parts, ordering words in sentences, and combining sound with print.[27] If problems exist, again the facilitating teacher provides both structured and spontaneous materials that allow the child to continuously explore number and relationships beginning concretely and progressing to the abstract.

·What additional limitations and abilities does the child bring that have developed through his own experiential background? Is the child extremely egocentric? If so, he may not be ready to be handed a basal preprimer which provides no motivation for him, other than pictures that soon grow old. He needs listening and sharing experiences and would most certainly benefit from a language experience approach to reading. Does the child seem able to create

mental pictures, both through memorization and forming new pictures? Without mental imagery, the child may find it impossible to remember sight words, see differences in such words as saw and was, or anticipate what might happen in a story. The facilitating teacher plans field trips and game experiences that give the child opportunities to develop his memory within a motivating context.

Finally, what are the situations in which the child seems to learn most easily? Is his learning achieved through quiet, contemplation or in a social context with other children? Does the child appear to use analysis or synthesis in achieving concepts? If the child uses predominantly analysis, the teacher uses methods such as a phonetic approach to reading and a demonstration approach to arithmetic. If the child uses predominantly synthesis, the teacher uses methods such as a language experience approach to reading and a discovery approach to arithmetic. Is the child a verbal, auditory, visual, or tactile learner? The facilitating teacher plans activities which allow for many learning styles including pictures, field trips, tape recordings, records, manipulatives, learner-directed and teacher-directed activities. These activities are planned and presented by the teacher and children, so that options are given to each individual child to accomplish an objective using the easiest method for him.

Summary

"Back to basics" can be considered important. However, cognitive theory suggests that the "3 R's" be "tackled" in a somewhat different manner. Through natural development, a child follows a distinct learning pattern. He/she comes to school, not to learn how to learn, but ready to learn. It then becomes dependent upon the educator to provide a developmentally oriented, activity environment, in which the child can use his own strengths both to enjoy learning and to prepare himself for adulthood.

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DEVELOPMENTAL
READING PROBLEMS

Sample Lesson Plan Objectives and Activities

Sample: Activities for building lesson plans

Child Behavior Description

Allen is a 6-year-old who continues to have difficulty ordering letters in a word. He knows the names of all the alphabet letters but cannot complete activities such as the fcllowins: A, B, C, _____, E. An even greater problem is in the ordering of letters within words; saw, was. He has been checked for eye problems and possible learning disabilities and was diagnosed as normal, with no physical problem.

Concept to be developed

Abstract relationships between letters.

Prerequisite Objectives	Sample Activities for Development by Teacher
Visual Relations:	
A. Size	A.(1) Present the child with 3 like objects (3 dolls, etc.) *Ask: "Put these in order from tallest to shortest, or smallest to biggest, etc." (2) Progress to 5 objects, 7 objects, 10 objects. Allow manipulation of objects for as many days as is necessary to understand ordering. (3) When familiar object relationships are easily formed, progress to more abstract objects such as sticks. (4) Next progress to pictures of objects (ex. cars cut from magazines). (5) Finally, use different size pictures mounted on cards of the same size for ordering. FOR ALL REMAINING ACTIVITIES, DESIGN LESSON PLAN TO PROGRESS FROM CONCRETE OBJECTS TO ABSTRACT FORMS.

*These activities are not designed to directly teach the concept. Children must build their own understandings. The activities are designed for such activities as learning centers and teacher manipulative discussions.

Note: Progression from concrete to abstract: 1. familiar objects 2. abstract (unfamiliar) objects 3. cutout pictures 4. pictures mounted on cards	
B. Color Intensity	B. Present glasses of red colored water varying in color intensity. Ask the child to order from lightest to darkest.
Tactile Relationships	
C. Matching	C. Present several textured mats attached to an answer board or folder with corresponding loose mats. Ask the child to match pairs according to texture.
D. Classifying	D. Ask the child to categorize textured mats according to rough/smooth concepts.
E. Ordering	E. Use objects of varied texture (silk, sandpaper, burlap, etc.). Ask the child to order from smoothest to roughest.
Auditory Relationships	
F. Matching	F. Make a tape of various simple sounds (horn, hands clapping, bell ringing, etc.). Have objects available. Ask the child to match the sound as he hears it.
G. Ordering	G. Make a tape of various familiar sounds to the child (horse, cow, telephone, etc.). Give toy objects to the child. After listening to the tape, ask the child to place the objects in the order presented on the tape.

Event Relationships	
H. Visual Events	H.(1) Use objects such as a (a) whole apple, (b) half eaten apple, (c) apple core. Ask the child to place the object in order. Request that he/she explain his actions. (2) If/when the child is successful with objects, use pictures of similar familiar events.
I. Auditory Event	I. Read motivating stories to the child. Ask him/her to order pictures of events in the story.
Language Relationships	Read the following list to the child one word at a time asking him/her to respond with a word: up black over in top If the child does not respond with the opposite word (down, white, under, out, bottom), develop concrete (objects and pictures) to abstract (language) activities for him.
Internalization of Alphabet Letters	
A. Recognition	A. Provide both choice and assigned task time during which the child constructs letters using various medium (see letter construction list.
B. Ordering	B. Use such materials as alphabet blocks, children as alphabet letters, etc. before written ordering of letters.